

Bioremediation of Explosives-Contaminated Soil

Restoring Facilities the Natural Way



Army installations face high costs to cleanup soil contaminated by past explosives operations. Remediation of these sites is a prerequisite for beneficial reuse and protection of the environment.

The Army has been searching for alternatives to treat soil and groundwater contaminated with explosives. Contamination of soils has occurred at Army installations where explosives were produced and handled according to practices that were considered standard at the time. **These installations require cost-effective techniques to treat large volumes of explosives-contaminated soils.** The U.S. Army Environmental Center is using bioremediation - boosting the activity of naturally occurring microorganisms - to eliminate explosive compounds from the soil. A number of processes are being demonstrated to validate different bioremediation technologies and obtain critical performance information to transfer application to other Army installations. Bioremediation uses nature's processes with simple technology, costs less than incineration, and has widespread public acceptance. Windrow composting and bioslurry offer two cost-effective methods for cleanup of explosives-contaminated soils.



USAEC

Environmental Technology Division

Enhanced Effectiveness and Environmentally Sensitive Cleanup



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A natural process called **bioremediation** is now available as an alternative cleanup remedy for explosives-contaminated soils. Bioremediation boosts the activity of naturally occurring microorganisms to degrade hazardous substances in soil or sediment into nontoxic materials.

COMPOSTING

Composting uses naturally occurring microorganisms to degrade organic wastes. This process is similar to that used for household yard waste. Increased temperatures from heat produced by microorganisms speed their metabolism and degradation of the organic materials in the waste.

Because of the modest equipment and monitoring requirements, windrow composting is a cost-effective technology, with a **high degree of treatment effectiveness** for explosives-contaminated soils at a **low process cost**.

Windrow composting mixes the soil with compost in long piles known as windrows. To facilitate the microbial growth, amendments such as wood chips, manure, straw, alfalfa, and other agricultural products are added. Windrows are used to facilitate aeration of the compost and are turned periodically using a compost turner. Moisture content, windrow oxygen level, and temperature are easily monitored.

Windrow composting was used in the cleanup of a Superfund Site at Umatilla Army Depot, OR. TNT reductions were as high as 99.7% and removals of RDX and HMX were 99.8% and 96.8%.

BIOSLURRY

For sites requiring greater process control, more complete degradation, or where the cost of importing compost amendments is prohibitive, **soil slurry biotreatment** or "bioslurry" is a bioremediation option. The contaminated materials are mixed into a slurry to allow contact between the microorganisms and the contaminants. Because conditions are optimized for the microorganisms, slurry processes are faster than many other biological processes. The treated slurry is suitable for direct land application, similar to finished compost.

Aerobic bioslurry is a destruction technology that achieved 99+% removal of TNT, HDX and RDX at Joliet Army Ammunition Plant, Illinois. Molasses was added as a microbial food source. Simple intermittent aeration permitted reactor conditions to cycle between aerobic and anoxic states, thus **optimizing total explosives degradation**. Metabolic fate studies showed **virtually complete breakdown** of the explosives molecule to CO₂, simple organic acids, and carbon fragments in the biomass.

Anaerobic Soil-Slurry

The Army is conducting a field test of a proprietary anaerobic bioslurry process on explosives-contaminated soils at Iowa Army Ammunition Plant, Iowa. The field test will provide performance and cost information to evaluate this process in relation to other bioremediation technologies.

Based on results of field demonstrations, USAEC has developed conceptual designs and cost estimates to enable users to apply these technologies full-scale.

Bioremediation cleanup

solutions are natural, safe, cost-effective, and proven for treating explosives-contaminated soil.